AUDIOACCESS

CONSUMER DIGITAL INTERFACE ä PROTOCOL
INSTRUCTIONS & OPERATION MANUAL

Audioaccess • 2081 South Main Street• Middletown, Conneticut 06457
Main Voice: 860-346-0896 Customer Support Toll Free 888-691-4171
Main Fax: 860-346-1540 Customer Support Fax 860-347-6251

DOC# AACONDI

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What is CONDI™ and how does it work?

CONDI™ is a communications protocol developed by Audioaccess for the purpose of controlling audio and video equipment. It is based on the EIA RS-485 electrical specification and utilizes collision sensing to allow multiple devices to send and receive on the same pair of wires. Data is communicated at 9600 baud, 8 data bits, 1 stop bit, and no parity.

Before beginning data transmission, the bus should be checked for inactivity. If the bus is free, transmission may commence. If the bus is being used, wait for a period of inactivity. Each transmission should be checked against the intended message, to ensure that data corruption did not occur due to multiple devices attempting to use the bus at the same time. For each valid data transmission not originating from the main controller (except Status Requests which require a different response), the main controller will automatically generate an acknowledgment (38*h*) (i.e. any information coming into the main controller gets an ACK). The device which sent the data should receive this acknowledgment before beginning its next data transmission. Under rare circumstances, the main controller may be performing a function which cannot be interrupted. The data should be retransmitted until an acknowledgment is received. Due to this fact, delays are required between incoming commands for the transmission of the required acknowledgment.

How does Audioaccess use CONDI™ ?

Audioaccess products use the CONDI™ protocol to communicate between keypads, multiple products, and the main controller. For example, whenever a button is pressed on a KPS keypad, the keypad transmits a data packet (as outlined on the following pages) to tell the main controller which button has been pressed. The keypad will continue to resend the data packet every 150 mSec *until the main controller sends an acknowledge back.* More specifically, whenever a button is pressed on a KPS keypad, two commands are transmitted. The first command occurs when the button is initially depressed and is referred to as the "DOWN CODE". The main controller will respond with an "ACKNOWLEDGE" code within 150 mSec. The main controller will additionally send a "LED ON" code corresponding to the button which was depressed. The second keypad command occurs either when the button is released or when the button is depressed for more than two seconds. These two commands are referred to as the "UP CODE" and the "LONG CODE", respectively. This is but an example of how CONDI™ is used by Audioaccess products. The other types of CONDI™ codes, such as Computer codes, work very similarly.

What is this document?

The first section of this document describes the structure of a CONDI™ code and what each byte means. The second section demonstrates the construction of sample CONDI™ codes. The subsequent sections list all of the available CONDI™ codes for each device type. Appendix A contains a description of the data bytes necessary to set the MRX tuner to a desired frequency. *Note:* the symbols "*b*", "*d*", and "*h*" used in this document denote binary, decimal, and hexadecimal values, respectively. All transmissions must be in eight-bit hexadecimal bytes.

CODE STRUCTURE

Preamble	System Code	Zone Code	Device Type	Command	Checksum

The Preamble is used to alert the system that a message is about to be transmitted. This allows the system to ignore random noise, and reliably receive valid messages. The Preamble is always equal to 7E*h*.

Preamble	System Code	Zone Code	Device Type	Command	Checksum

The System and Zone codes are used to identify which room in the system a message is from or is intended for. The System and Zone codes also include a Room code, as follows:

System Code	Zone Code
$R_2S_3S_2S_1$ 0000*b*	0000 $R_1Z_3Z_2Z_1$*b*

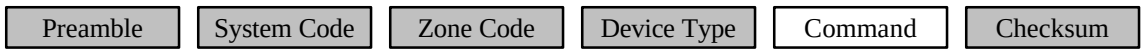
where $S_3S_2S_1$*b* = System 0-6 in binary
System 0 is the Main Sys. in a Single Sys.
System 1 is the Main Sys. in a Multi-Sys.
$Z_3Z_2Z_1$*b* = Zone 1-6 in binary
Zone 6 is the Main Zone.
R_2R_1*b* = Room 0-3 in binary
Room 0 is the Main Room.

Preamble	System Code	Zone Code	Device Type	Command	Checksum

The Device Type is used to determine which piece of equipment in the system that a message applies to. Each Device Type has its own set of commands (i.e. a KPS Keypad command 71*h* is not the same as a Computer command 71*h*).

KPS Keypad = 01*h*
Computer = 04*h*
Reserved = 05*h*
PX-603 = 06*h*
Reserved = 07*h*

CODE STRUCTURE (CONT.)



The Command is the actual message. It may either be a single byte, four bytes, or five bytes long, depending on the particular code. For example, Volume Up is a single byte and Set Level is four bytes (Set Level, Volume, Bass, and Treble).

The Checksum is a byte whose value confirms/voids the validity of a received message. It is computed by adding up the Preamble, System Code, Zone Code, Device Type, and all bytes of the Command, and then taking the 1's complement of the lower eight bits of that sum (i.e. add up all the bytes, truncate to eight bits, and invert each of the bits). If the result equals 7E*h*, add 01*h*.

SINGLE BYTE COMMAND SAMPLE

Create a Volume Up command from a KPS Keypad in Room 3 of Zone 5 of System 4.

Preamble = 7E*h*

System 4 = $S_3S_2S_1$ = 100*b*
Zone 5 = $Z_3Z_2Z_1$ = 101*b*
Room 3 = R_2R_1 = 11*b*

System Code = $R_2S_3S_2S_1$ 0000*b* = 1100 0000*b* = C0*h*
Zone Code = 0000 $R_1Z_3Z_2Z_1$*b* = 0000 1101*b* = 0D*h*

Device Type = KPS Keypad = 01*h*

Command = Volume Up = 71*h*

0111 1110*b* (7E*h*)
1100 0000*b* (C0*h*)
0000 1101*b* (0D*h*)
0000 0001*b* (01*h*)
+ 0111 0001*b* (71*h*)

1 1011 1101*b* (sum = 1BD*h*)

1011 1101*b* (truncating = BD*h*)

0100 0010*b* (inverting bits = 42*h*)

0100 0010*b* (42*h* ≠ 7E*h*, so don't add 01*h*)

Checksum = 42*h*

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	C0*h*	0D*h*	01*h*	71*h*	42*h*

MULTI BYTE COMMAND SAMPLE

Create a Set Main Room Level command from a Computer for Zone 3 of System 1.
Volume = -6dB, Bass = +3dB, Treble = +0dB

Preamble = 7E*h*

System 1 = $S_3S_2S_1$ = 001*b*
Zone 3 = $Z_3Z_2Z_1$ = 011*b*
Room 0 = R_2R_1 = 00*b*

System Code = $R_2S_3S_2S_1$ 0000*b* = 0001 0000*b* = 10*h*
Zone Code = 0000 $R_1Z_3Z_2Z_1$*b* = 0000 0011*b* = 03*h*

Device Type = Computer = 04*h*

Command = Set Main Room Level = 71*h*

Volume = -6dB = 35*h* - 3(2dB steps) = 32*h*

Bass = +3dB = 07*h* + 1(3dB step) = 08*h*

Treble = +0dB = 07*h* + 0(3dB steps) = 07*h*

```
  0111 1110b (7Eh)
  0001 0000b (10h)
  0000 0011b (03h)
  0000 0100b (04h)
  0111 0001b (71h)
  0011 0010b (32h)
  0000 1000b (08h)
+ 0000 0111b (07h)
-----------------
1 0100 0111b (sum = 147h)

  0100 0111b (truncating = 47h)

  1011 1000b (inverting bits = B8h)

  1011 1000b (B8h ≠ 7Eh, so don't add 01h)
```

Checksum = B8*h*

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	10*h*	03*h*	04*h*	71*h*,32*h*,08*h*,07*h*	B8*h*

KPS KEYPAD COMMANDS

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	$R_2S_3S_2S_1$ 0000*b*	0000 $R_1Z_3Z_2Z_1$*b*	01*h*	See below	See page 4

HEX	COMMAND DESCRIPTION
10	POWER BUTTON DOWN
11	POWER BUTTON UP
12	POWER BUTTON LONG
32	POWER LED ON
33	POWER LED OFF
30	FM & POWER LED ON
31	ALL LEDs OFF
01	FM BUTTON DOWN
02	FM BUTTON UP
03	FM BUTTON LONG
21	FM LED ON
22	FM LED OFF
04	CD BUTTON DOWN
05	CD BUTTON UP
06	CD BUTTON LONG
24	CD LED ON
25	CD LED OFF
07	TAPE BUTTON DOWN
08	TAPE BUTTON UP
09	TAPE BUTTON LONG
27	TAPE LED ON
28	TAPE LED OFF
0A	AUX BUTTON DOWN
0B	AUX BUTTON UP
0C	AUX BUTTON LONG
2A	AUX LED ON
2B	AUX LED OFF
0D	VID BUTTON DOWN
0E	VID BUTTON UP
0F	VID BUTTON LONG
2D	VID LED ON
2E	VID LED OFF

Note: KPS Keypad Button commands are listed here for informational purposes, only. They should not be used to control the system. See the Computer Commands section for commands that should be used to interact with the system.

Note: All Keypad Button commands are used in pairs (i.e. a Down code followed by either an Up or Long code). Remote Control and Volume commands (see next page) are used in singles. Each of these codes is acknowledged by the main controller. In addition to the Acknowledge, the main controller responds with an LED command, if appropriate. The LED command is NOT acknowleged, as it originates at the main controller. Sample:

KPS: CD Button Down
MC: Acknowledge
CD LED On

KPS: CD Button Up
MC: Acknowledge

Only one KPS Source LED may be lit at one time. Sending a Source LED On command causes all other Source LEDs to go out automatically, so there is no need to send a separate LED Off command before sending an LED On command.

The FM & Power LED On command causes both the FM and Power LEDs to be lit. The Power LED On and Power LED Off commands give independent control of the Power LED, regardless of the status of the Source LEDs.

KPS KEYPAD COMMANDS (CONT.)

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	$R_2S_3S_2S_1$ 0000*b*	0000 $R_1Z_3Z_2Z_1$*b*	01*h*	See below	See page 4

HEX	COMMAND DESCRIPTION
71	VOLUME UP
B1	VOLUME DOWN
F1	MUTE
79	REMOTE CONTROL PLAY BUTTON
B9	REMOTE CONTROL STOP BUTTON
E9	REMOTE CONTROL PAUSE BUTTON
F9	REMOTE CONTROL FAST FORWARD BUTTON
39	REMOTE CONTROL REWIND BUTTON
29	REMOTE CONTROL TV/VCR BUTTON
69	REMOTE CONTROL CHANNEL UP BUTTON
A9	REMOTE CONTROL CHANNEL DOWN BUTTON
DE	REMOTE CONTROL BUTTON 1 DOWN
DF	REMOTE CONTROL BUTTON 1 UP
E0	REMOTE CONTROL BUTTON 1 LONG
EE	REMOTE CONTROL BUTTON 2 DOWN
EF	REMOTE CONTROL BUTTON 2 UP
F0	REMOTE CONTROL BUTTON 2 LONG
CE	REMOTE CONTROL BUTTON 3 DOWN
CF	REMOTE CONTROL BUTTON 3 UP
D0	REMOTE CONTROL BUTTON 3 LONG
F6	REMOTE CONTROL BUTTON 4 DOWN
F7	REMOTE CONTROL BUTTON 4 UP
F8	REMOTE CONTROL BUTTON 4 LONG
35	KEYPAD UPDATE REQUEST
38	ACKNOWLEDGE
7E	RESERVED

Note: These functions are available only from an RT-A or URC-5000 remote control.

Note: These functions are available only from an RT-A or URC-5000 remote control.

On the RT-A, they are the unmarked buttons located on the left side of the remote. They are numbered from top to bottom.

On the URC-5000, they are the buttons located at the bottom of the remote.
Button D = Button 1
Button F = Button 2
Button H = Button 3
Button 4 is unavailable from a URC-5000.

One request causes the main controller to update the status of ALL keypads in its system. Therefore, a KEYPAD UPDATE REQUEST must be generated for each system in a Multi-System configuration.

COMPUTER COMMANDS

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	$R_2S_3S_2S_1$ 0000*b*	0000 $R_1Z_3Z_2Z_1$*b*	04*h*	See below	See page 4

HEX	COMMAND DESCRIPTION
40	ROOM ON
41	ROOM OFF
42	ROOM ALL-ON
43	ROOM ALL-OFF
F2	MUTE ON
F3	MUTE OFF
01	SELECT TUNER (equivalent to a KPS button Down and Up combination)
03	SELECT NEXT TUNER (equivalent to a KPS button Down and Long combination)
04	SELECT CD
06	SELECT NEXT CD
07	SELECT TAPE
09	SELECT NEXT TAPE
0A	SELECT AUX
0C	SELECT NEXT AUX
0D	SELECT VIDEO
0F	SELECT NEXT VIDEO
44	SELECT PAGE
79	REMOTE CONTROL PLAY BUTTON
B9	REMOTE CONTROL STOP BUTTON
E9	REMOTE CONTROL PAUSE BUTTON
F9	REMOTE CONTROL FAST FORWARD BUTTON
39	REMOTE CONTROL REWIND BUTTON
29	REMOTE CONTROL TV/VCR BUTTON
69	REMOTE CONTROL CHANNEL UP BUTTON
A9	REMOTE CONTROL CHANNEL DOWN BUTTON
DE	REMOTE CONTROL BUTTON 1 DOWN
DF	REMOTE CONTROL BUTTON 1 UP
E0	REMOTE CONTROL BUTTON 1 LONG
EE	REMOTE CONTROL BUTTON 2 DOWN
EF	REMOTE CONTROL BUTTON 2 UP
F0	REMOTE CONTROL BUTTON 2 LONG
CE	REMOTE CONTROL BUTTON 3 DOWN
CF	REMOTE CONTROL BUTTON 3 UP
D0	REMOTE CONTROL BUTTON 3 LONG

Note: Computer commands should be used anytime another controller wishes to interact with the Audioaccess system, such as in a whole-house automation application. KPS Keypad commands should only be used for informational purposes.

Note: It is not necessary to issue Computer Commands in pairs (i.e. a Down and an Up).

Note: When the Select commands are issued to a Room which is not On., the Room is automatically turned On. There is no need to send a "ROOM ON" command and then a "SELECT CD" command; simply send a "SELECT CD" command. The Room will turn On, Tuner will be selected until all power-up IR codes are sent, and then selection will change to CD.

Note: Remote Control Button commands differ from all other Computer Commands in that they **should** be used in pairs (i.e. Down and Up or Down and Long).

COMPUTER COMMANDS (CONT.)

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	$R_2S_3S_2S_1$ 0000*b*	0000 $R_1Z_3Z_2Z_1$*b*	04*h*	See below	See page 4

HEX	COMMAND DESCRIPTION
F6	REMOTE CONTROL BUTTON 4 DOWN
F7	REMOTE CONTROL BUTTON 4 UP
F8	REMOTE CONTROL BUTTON 4 LONG

50 MAIN ROOM STATUS REQUEST

63 MAIN ROOM STATUS RESPONSE (5 bytes)

MAIN ROOM STATUS RESPONSE, SOURCE SELECTION, VOLUME, BASS, TREBLE
Source Selection: 00*h* = Off, 01*h* = Tuner, 02*h* = CD, 03*h* = Tape, 04*h* = Aux, and 05*h* = Video
Volume: 00*h* (mute) through 3F*h* (+20). 35*h* is unity gain. 2dB steps.
Bass: 00*h* (-12dB cut) through 0F*h* (+15dB boost). 07*h* is flat. 3dB steps.
Treble: 00*h* (-12dB cut) through 0F*h* (+12dB boost). 07*h* is flat. 3dB steps.

Note: When the main controller receives a "MAIN ROOM STATUS REQUEST", no "ACKNOWLEDGE" is generated; but rather, a "MAIN ROOM STATUS RESPONSE".

If the status of a room other than the Main Room (Room 0) in a Zone is needed, use a "PX-603 ROOM STATUS REQUEST" PX-603 Command, in addition to a "MAIN ROOM STATUS REQUEST" Computer Command. Use the "MAIN ROOM STATUS REQUEST" Computer Command to obtain the source selection information for the Zone, and the "PX-603 ROOM STATUS REQUEST" PX-603 Command to obtain the volume information for the specific requested room.

71 SET MAIN ROOM LEVEL (4 bytes)

SET MAIN ROOM LEVEL, VOLUME, BASS, TREBLE
Volume: 00*h* (mute) through 3F*h* (+20). 35*h* is unity gain. 2dB steps.
Bass: 00*h* (-12dB cut) through 0F*h* (+15dB boost). 07*h* is flat. 3dB steps.
Treble: 00*h* (-12dB cut) through 0F*h* (+12dB boost). 07*h* is flat. 3dB steps.

51 MRX TUNER STATUS REQUEST

62 MRX TUNER STATUS RESPONSE (4 bytes)

MRX TUNER RESPONSE, BYTE1, BYTE2, BYTE3
Refer to Appendix A for more information on how Byte1, Byte2, and Byte3 are derived.
Example: Byte1 = 86*h*, Byte2 = 03*h*, and Byte3 = D6*h* for 87.5 Mhz.

Note: When the main controller receives a "MRX TUNER STATUS REQUEST", no "ACKNOWLEDGE" is generated; but rather, a "MRX TUNER STATUS RESPONSE".

70 SET MRX TUNER (4 bytes)

SET MRX TUNER, BYTE1, BYTE2, BYTE3
Refer to Appendix A for more information on how Byte1, Byte2, and Byte3 are derived.
Example: Byte1 = 86*h*, Byte2 = 03*h*, and Byte3 = D6*h* for 87.5 MHz.

38 ACKNOWLEDGE

7E RESERVED

PX-603 COMMANDS

Preamble	System Code	Zone Code	Device Type	Command	Checksum
7E*h*	$R_2S_3S_2S_1$ 0000*b*	0000 $R_1Z_3Z_2Z_1$*b*	06*h*	See below	See page 4

HEX COMMAND DESCRIPTION

Note: KP3 keypads have no commands of their own. They emulate KPS keypads; and therefore, generate KPS keypad commands.

50 PX-603 ROOM STATUS REQUEST

63 PX-603 ROOM STATUS RESPONSE (5 bytes)

ROOM STATUS RESPONSE, SOURCE SELECTION, VOLUME, BASS, TREBLE
Source Selection: 00*h* (not used).
Volume: 00*h* (mute) through 35*h* (unity gain). 2dB steps.
Bass: 00*h* (not used).
Treble: 00*h* (not used).

Note: see "MAIN ROOM STATUS REQUEST" in Computer Commands for further comments concerning status requests.

72 SET PX-603 ROOM LEVEL (4 bytes)

SET LEVEL, VOLUME, BASS, TREBLE
Volume: 00*h* (mute) through 35*h* (unity gain). 2dB steps.
Bass: 00*h* (not used).
Treble: 00*h* (not used).

Note: Bass and Treble bytes must be included in the command, even though they are not used. Bass may be adjusted manually for PX-603 rooms by dip switches on the rear panel of those units.

38 ACKNOWLEDGE

7E RESERVED

APPENDIX A
MRX TUNER CODES

FM channel spacing is 0.2 MHz for the USA (use every-other 0.1 MHz code) and 0.05 MHz for Europe. Other countries may have 0.1 MHz FM spacing channel. AM channel spacing is 10 kHz for the USA and 9 kHz for Europe. Other countries may have either 9 kHz or 10 kHz spacing.

The codes (Byte1, Byte2, and Byte3) have a linear relationship to the frequencies which they represent. Use the formulas appropriate for your area to determine the codes necessary to tune the MRX tuner to your local stations. The first and last three frequencies for each band and channel spacing are provided to assist in debugging.

*NOTE: In MRX software versions lower than 3.21, it is impossible to tune to FM 103.4 MHz due to one of the frequency setting data bytes having a value of "7E". This problem has been corrected in MRX software versions 3.21 and later.

FM 0.1 MHz channel spacing codes: 86,03,D6 (87.5 MHz) to 86,04,A2 (108.0 MHz).
FM 0.05 MHz channel spacing codes: C6,07,AC (87.50 MHz) to C6,09,46 (108.00 MHz).
AM 10 kHz channel spacing codes: 15,06,10 (520 kHz) to 15,0D,80 (1710 kHz).
AM 9 kHz channel spacing codes: 55,06,C0 (522 kHz) to 55,0E,50 (1611 kHz).

FM 0.1 MHz channel spacing:

Frequency	Byte1	Byte2	Byte3
87.5 MHz	86	03	D6
87.6 MHz	86	03	D7
87.7 MHz	86	03	D8

$$\frac{(\text{Desired Station } d - 87.5d)}{0.1d} + 8603D6h = \text{Desired Code}h$$

107.8 MHz	86	04	A1
107.9 MHz	86	04	A2
108.0 MHz	86	04	A3

FM 0.05 MHz channel spacing:

Frequency	Byte1	Byte2	Byte3
87.50 MHz	C6	07	AC
87.55 MHz	C6	07	AD
87.60 MHz	C6	07	AE

$$\frac{(\text{Desired Station } d - 87.50d)}{0.05d} + \text{C607AC}h = \text{Desired Code}h$$

107.90 MHz	C6	09	44
107.95 MHz	C6	09	45
108.00 MHz	C6	09	46

SAMPLE

Create Byte1, Byte2, and Byte3 necessary to tune the MRX tuner to 107.8 MHz.

$$\frac{(107.8\,d - 87.5d)}{0.1d} + 8603\text{D6}h = 8604\text{A1}h$$

Byte1 = 86*h*
Byte2 = 04*h*
Byte3 = A1*h*

AM 10 kHz channel spacing:

Frequency	Byte1	Byte2	Byte3
520 kHz	15	06	10
530 kHz	15	06	20
540 kHz	15	06	30

$$\frac{(\text{Desired Station } d - 520d)}{10d} + 15061h = \text{Sum}h$$

Shift Left Four Bits (Sum*h*) = Desired Code*h*

1690 kHz	15	0D	60
1700 kHz	15	0D	70
1710 kHz	15	0D	80

AM 9 kHz channel spacing:

Frequency	Byte1	Byte2	Byte3
522 kHz	55	06	C0
531 kHz	55	06	D0
540 kHz	55	06	E0

$$\frac{(\text{Desired Station } d - 522d)}{9d} + 5506Ch = \text{Sum}h$$

Shift Left Four Bits (Sum*h*) = Desired Code*h*

1593 kHz	55	0E	30
1602 kHz	55	0E	40
1611 kHz	55	0E	50

SAMPLE

Create Byte1, Byte2, and Byte3 necessary to tune the MRX tuner to 1593 kHz.

$$\frac{(1593d - 522d)}{9d} + 5506Ch = 550E3h$$

Shift Left Four Bits (550E3*h*) = 550E30*h*

Byte1 = 55*h*
Byte2 = 0E*h*
Byte3 = 30*h*